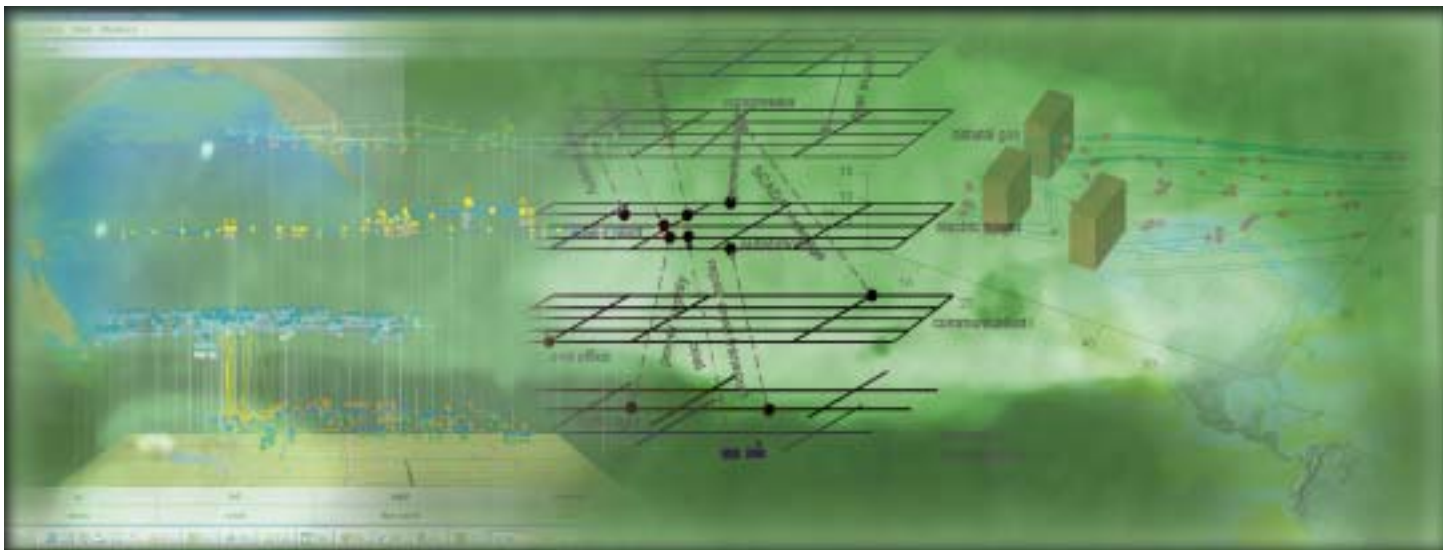
Los Alamos National Laboratory

Energy and Environment Programs

Compendium



complex integrated systemsportfolio

10.21.02

National Fossil Infrastructure Simulation System

KEY CAPABILITIES	Agent-Based Simulation • Simulation Science Decision-Analysis Tools

SITUATION — Realizing the Need for Integrated Modeling of the Fossil Fuel Industry's Infrastructure

Unprecedented changes are taking place in the energy industry, nationwide and globally. Several pending policy issues related to the fossil fuel industry infrastructure could reverberate throughout the industry—such as the DOE Office of Fossil Energy Vision 21, possible regulations on CO_2 emissions, and on-going restructuring of the electrical power industry. With the complex, interdependent nature of the fossil fuel industry's infrastructure, determining the impact of such policy decisions before they are implemented is essential to the vitality of the industry. Since adequate simulation models to provide policy makers guidance in the fossil-fuel area don't currently exist, Los Alamos has proposed a detailed simulation that includes all of the important industry components and their interactions: FOSSILSIMS.

INNOVATION — Redesigning Software Architecture for New Simulation Techniques

During the last 3 years, Los Alamos has been developing software architecture for the simulation, modeling, and analysis of interdependent infrastructures. With new simulation-science techniques and high-performance computing, Los Alamos is now able to develop a simulation that can address policy questions and their potential impacts on the complete infrastructure. As an agent-based simulator of the fossil energy industries and markets, FOSSILSIMS will be able to:

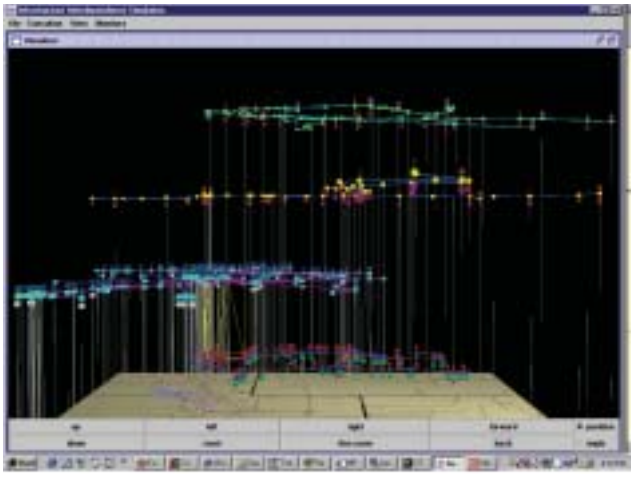
- Incorporate all of the important industry components and their interactions;
- Include the actions of the various people who impact (and are impacted by) the industry such as: consumers, regulators, government officials, investors, and CEOs;
- Treat multiple levels of component aggregation;
- Allow integrated modeling of markets and infrastructure for fossil energy; and
- Foster a detailed, unified framework of the infrastructures and networks that prepare, ship, and use the 3 fossil fuels—natural gas, petroleum, and coal.

APPLICATION — Understanding the Impacts of Policy Decisions

As a policy analysis tool, FOSSILSIMS could assist Federal agency and department personnel who make rules, industry personnel who must abide by regulations, investment bankers who make financial decisions on new installations, and academic and public interest people who wish to assess likely consequences.

Allowing analysis at a level of detail and depth heretofore impossible, FOSSILSIMS will be able to predict the impacts of:

- Transforming from various fossil-fuel types to others;
- Using various fuel types taking into account the complete fuel cycle;
- Persuading people to change their behavior;
- Introducing new governmental regulations; and
- Trading CO_2 emissions with other countries.



Jim Bossert • 505.667.6268 • bossert@lanl.gov

Electric Industry Simulation System

Thrust Area: **Energy Security**

KEY CAPABILITIES | High-Performance Computing • Modeling and Simulation

SITUATION Questioning How Restructuring Will Affect the Electric Power Industry and the Nation

In the mid-1990s, states began to explore and openly debate the possibility of restructuring their electricity supply networks and institutions. Following California's lead, approximately 25 states have passed legislation or introduced regulatory changes to begin electric industry restructuring. All of this activity created real-world experiments in a critically important economic sector of the United States.

The results of California's efforts are now well known. While other states have had less dramatic problems, most industry observers now realize that the restructuring process will, at best, consume years with occasional acute problems quite likely. As it is now, we have no mechanism within which to examine such changes in policy.

INNOVATION Examining Restructuring Initiatives to be Examined in a Uniquely Detailed Modeling Environment

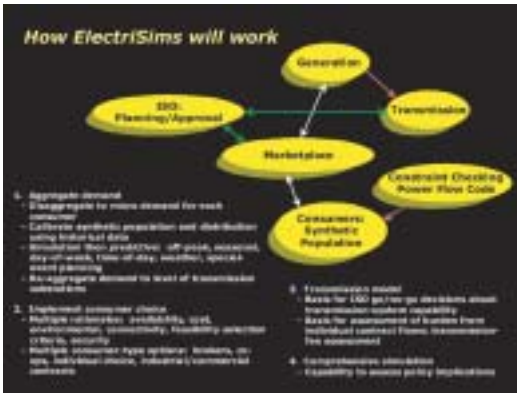
The Electric Industry Simulation System (ELISIMS) employs Los Alamos capabilities in agent-based modeling, high-performance computing, and electric industry domain expertise in D-Division gained through a decade of projects focused on identifying grid vulnerabilities. The simulation system was envisioned to:

- Model all of the independent components of the generation and transmission network;
- Encompass a continental scale (the contiguous 48 states and portions of Canada and Mexico) with a decomposable design architecture that can equally address regionally-focused problems;
- Factor economic behavior as the motivation of independent industry and consumer agents.
- Permit behavioral responses by modeled industry agents and consumers with the possibility of adjusting policy initiatives to induce the correct or desired responses; and
- Help avoid unforeseen problems that would arise with real world applications.

APPLICATION Predicting Conflicts and Providing Solutions

The fully realized simulation system could be used to:

- Resolve conflicts between industry and governmental and regulatory authority about how the industry should be structured and what new rules should be;
- Smooth the transition of the electric power industry from a regulated monopoly to a competitive industry; and
- Lessen the economic losses of restructuring, such as those sustained in California, that will probably be experienced elsewhere.



Jim Bossert•505.667.6268•bossert@lanl.gov

Interdependent Energy Infrastructure Simulation System

Thrust Area: **Energy Security**

KEY CAPABILITIES	Decision Analysis • Modeling and Simulation High-Performance Computing

SITUATION — Predicting Impacts of Policy Decisions on an Interdependent Energy Infrastructure

The energy, transportation, and communication infrastructures are extremely complex systems consisting of both physical facilities (such as power plants, transmission lines, and roads) and human decision makers (such as consumers, regulators, legislators, investors, CEOs). While significant interdependencies are apparent, gaps exist in the capability to analyze multiple contingency events involving the energy, transportation, and communication infrastructures. These gaps can create serious problems when policy decisions are made with no insight as to the possible impacts on these interdependent infrastructures. At present, adequate simulation models to determine the impact of policy and security decisions do not exist. To address questions of infrastructure interdependency, Los Alamos is developing a comprehensive simulation of the national interdependent energy infrastructures.

INNOVATION — Modeling and Simulating the Nation's Interdependent Energy Infrastructure

With Laboratory modeling and simulation capabilities, Los Alamos researchers are formulating the Interdependent Energy Infrastructure Simulation System (IEISS) to:

- Incorporate all of the important industry components;
- Exhibit the interactions between industry components; and
- Include statistically derived synthetic populations that exhibit behavior similar to that of the various human groups that impact (and are impacted by) the interdependent infrastructures.

While past models have analyzed individual components as stand-alone entities, the IEISS allows for a holistic analytic approach. Powered by the high-performance computing of the Laboratory, IEISS overcomes the inflexible and inadequate modeling and simulation technology base that has hampered other interdependent infrastructure analysis efforts.

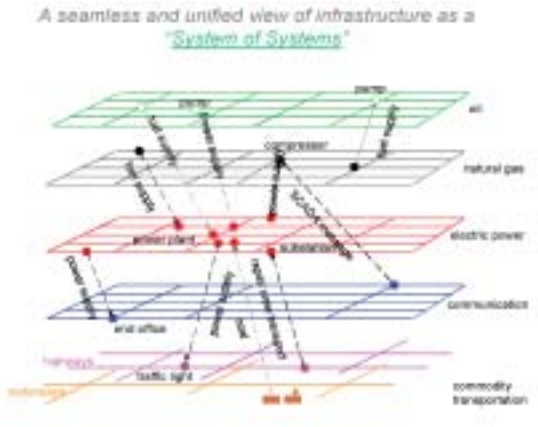
APPLICATION — Assessing and Addressing the Vulnerabilities of the Nation's Energy Infrastructure

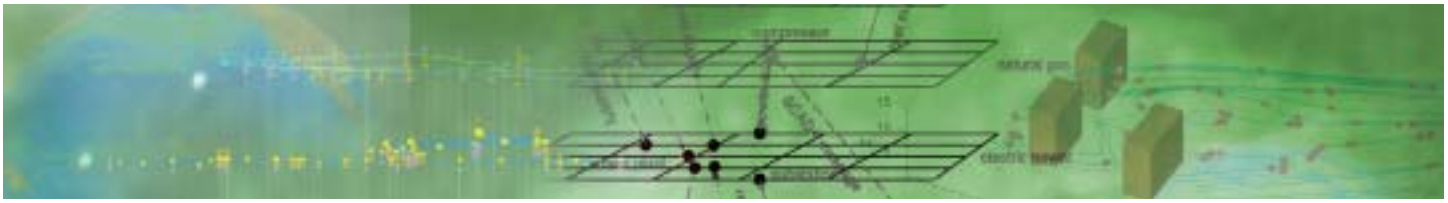
The national security of the United States depends, in large measure, upon the strength of its critical energy infrastructures: electric power, oil, natural gas, coal transportation, and control system communications. To ensure the lasting strength of these infrastructures, IEISS will assess:

- Infrastructure interdependency;
- Vulnerability/criticality;
- Emergency response management;
- Post-crisis consequences; and
- Pre-crisis planning and training.

From such assessments, the IEISS system will help decision-makers:

- Determine cost-saving solutions;
- Understand infrastructure interdependencies for normal operations as well as disruptions;
- Analyze marketplace dynamics from reliability, security, economic, and social perspectives;
- Integrate infrastructure protection, mitigation, response, and recovery options; and
- Assess the technical, economic, and national security implications of altered infrastructures.





Prepared for:

Los Alamos National Laboratory
Los Alamos, New Mexico

Prepared by:

National Environmental Technology Network (NETN)
of the
University of New Mexico School of Engineering
part of the
Consortium for Environmental Education and Technology Development (WERC)

NETN Director: Connie Callan
University of New Mexico
Bldg EECE L216
Albuquerque, NM 87131
1-800-292-7051

Compendium Staff:
Lead Writer / Editor: Brian Cosbey
Assistant Writers / Editors: Lesley Molecke, Michael Bradshaw Stephanie Phillips
Graphic Artists / Designers: Louis Vogel, Ezra Sandoval

LALP-02-216

Los Alamos
NATIONAL LABORATORY